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# (54) Locking device for a belt retractor in safety belts

(57) An emergency locking seat belt retractor includes an inertia sensor, a trip lever responsive to the sensor and a driver finger 71 on the trip lever. A separate locking pawl 4 engageable with a ratchet wheel 3 is provided in the retractor and includes a pin which is normally spaced from the driver finger 71 by a distance 'a'. Sudden vehicle deceleration causes sensor ball 6 to move so pivoting lever 7 to position tip 72 in the path of the teeth of plastic trip wheel 8, which deceleration also sets in motion by unwinding of the belt. Finger 71 now contacts pin 9 and so rotation of wheel 8 is transmitted via this pin 9 to locking pawl 4, so that its teeth 41 engage ratchet wheel 3 to halt its rotation and so lock the seat belt.

An acceleration sensor may additionally be provided, acting directly on trip lever 7.

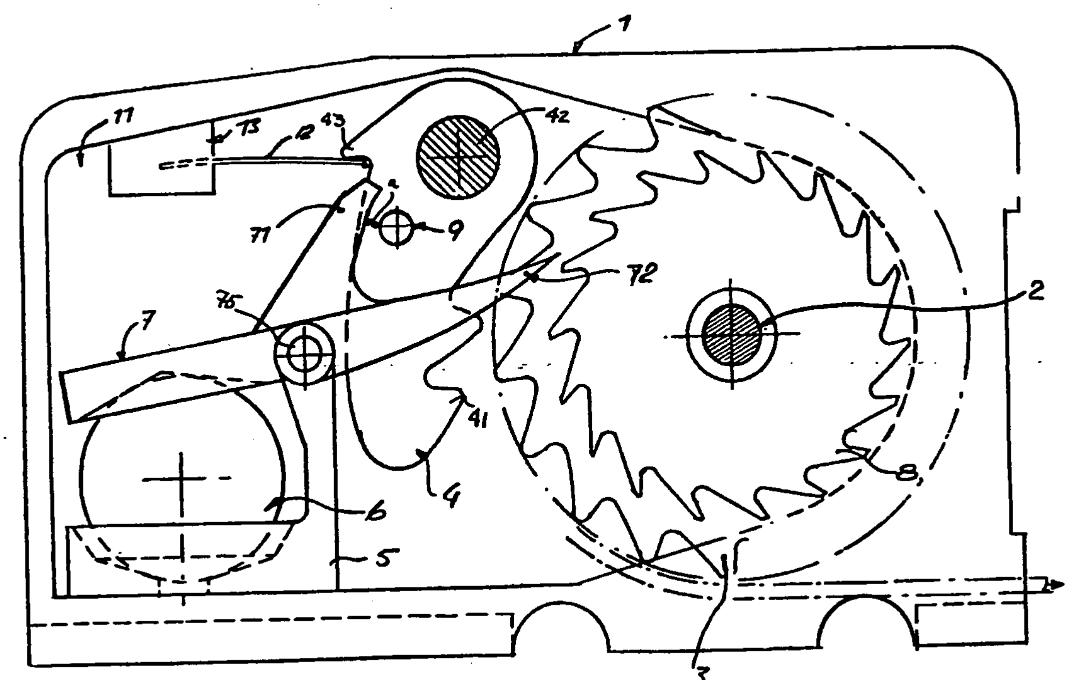


Fig 1



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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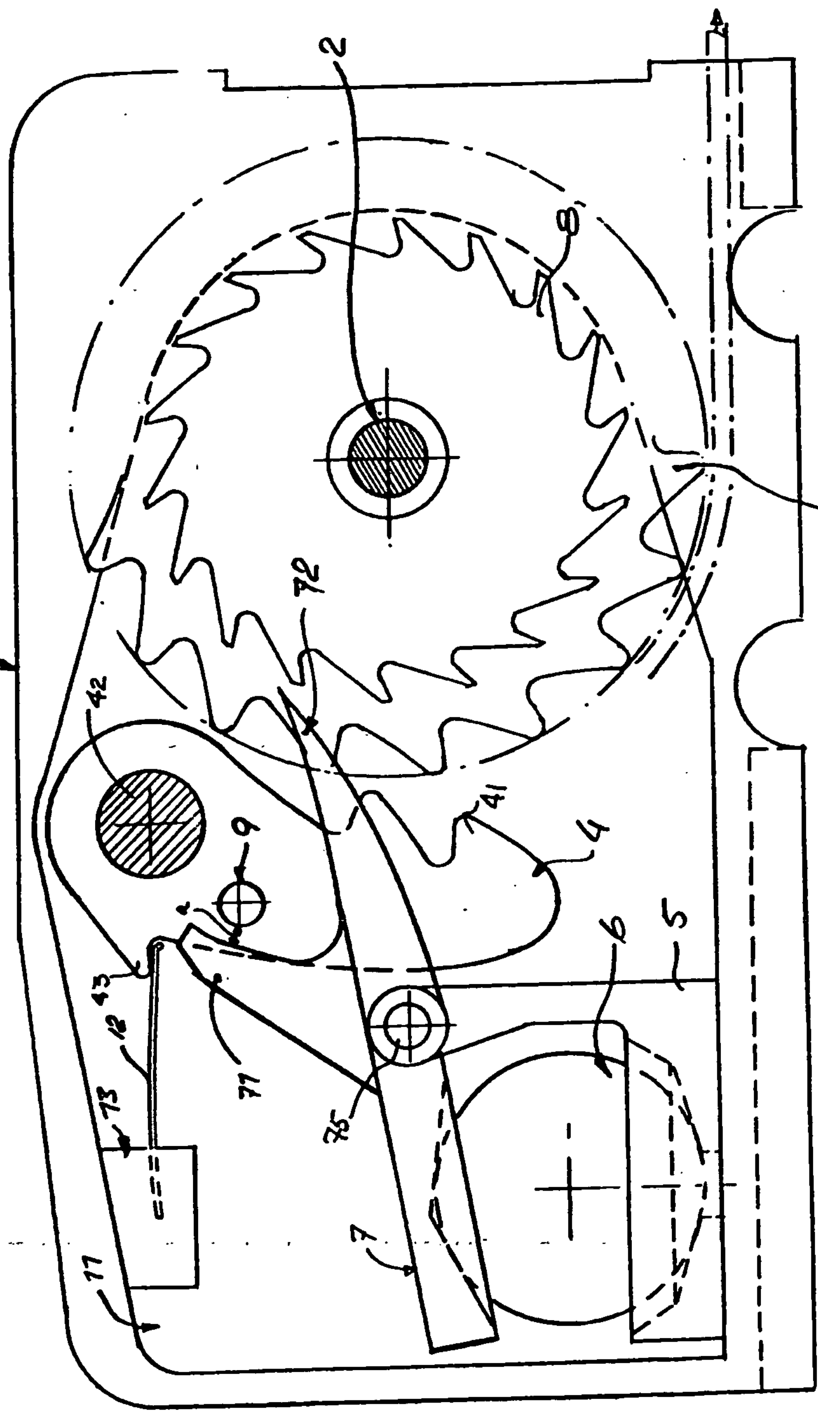


Fig 1

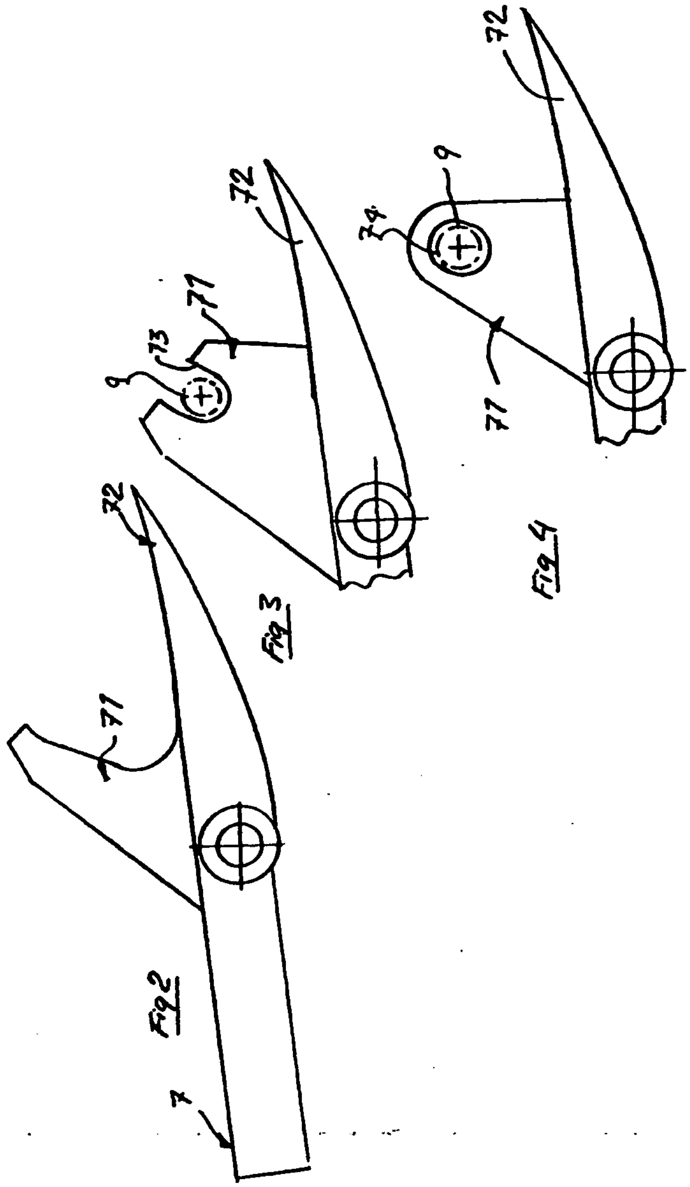


Fig 2

Fig 3

Fig 4

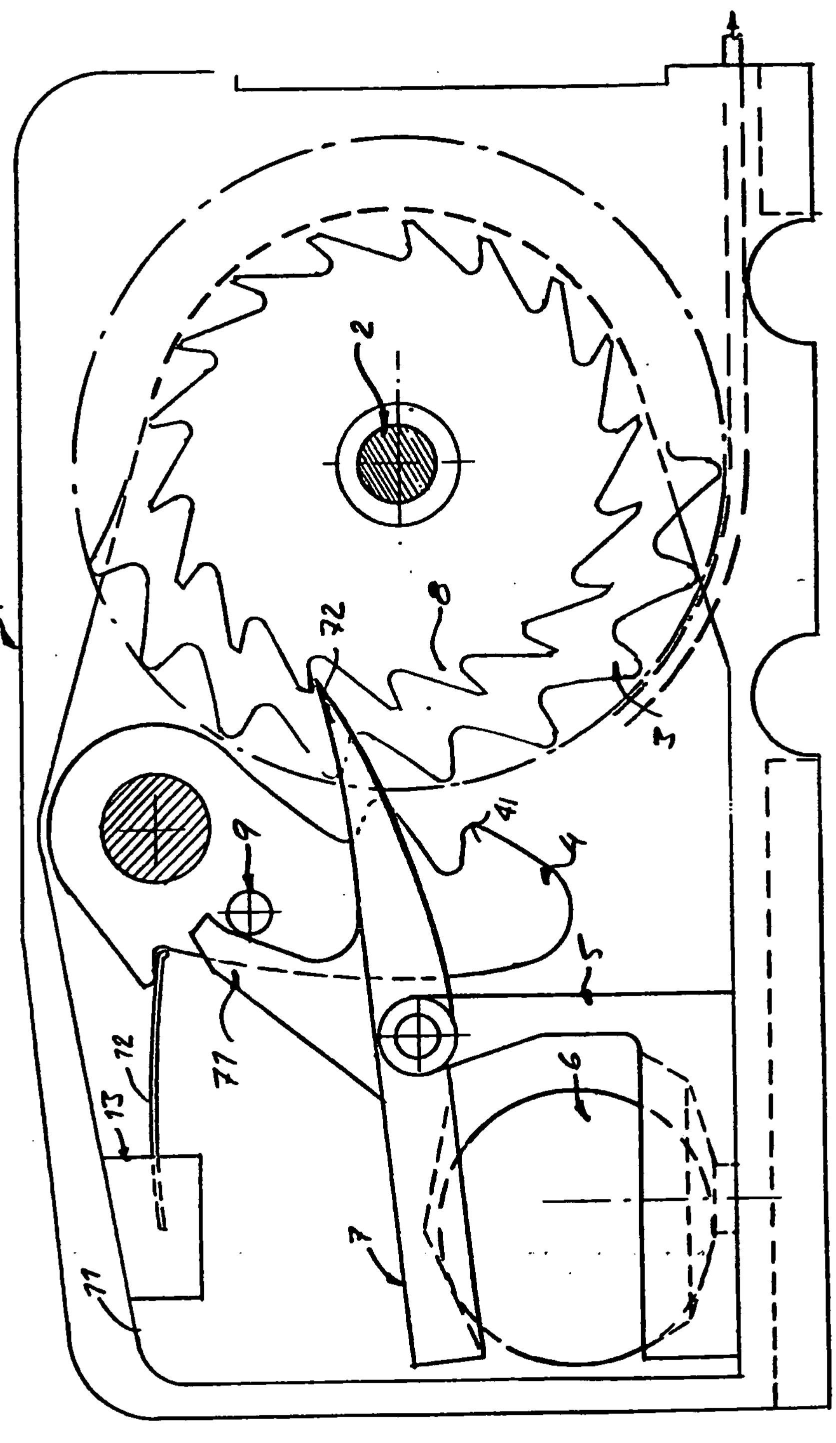


Fig. 5

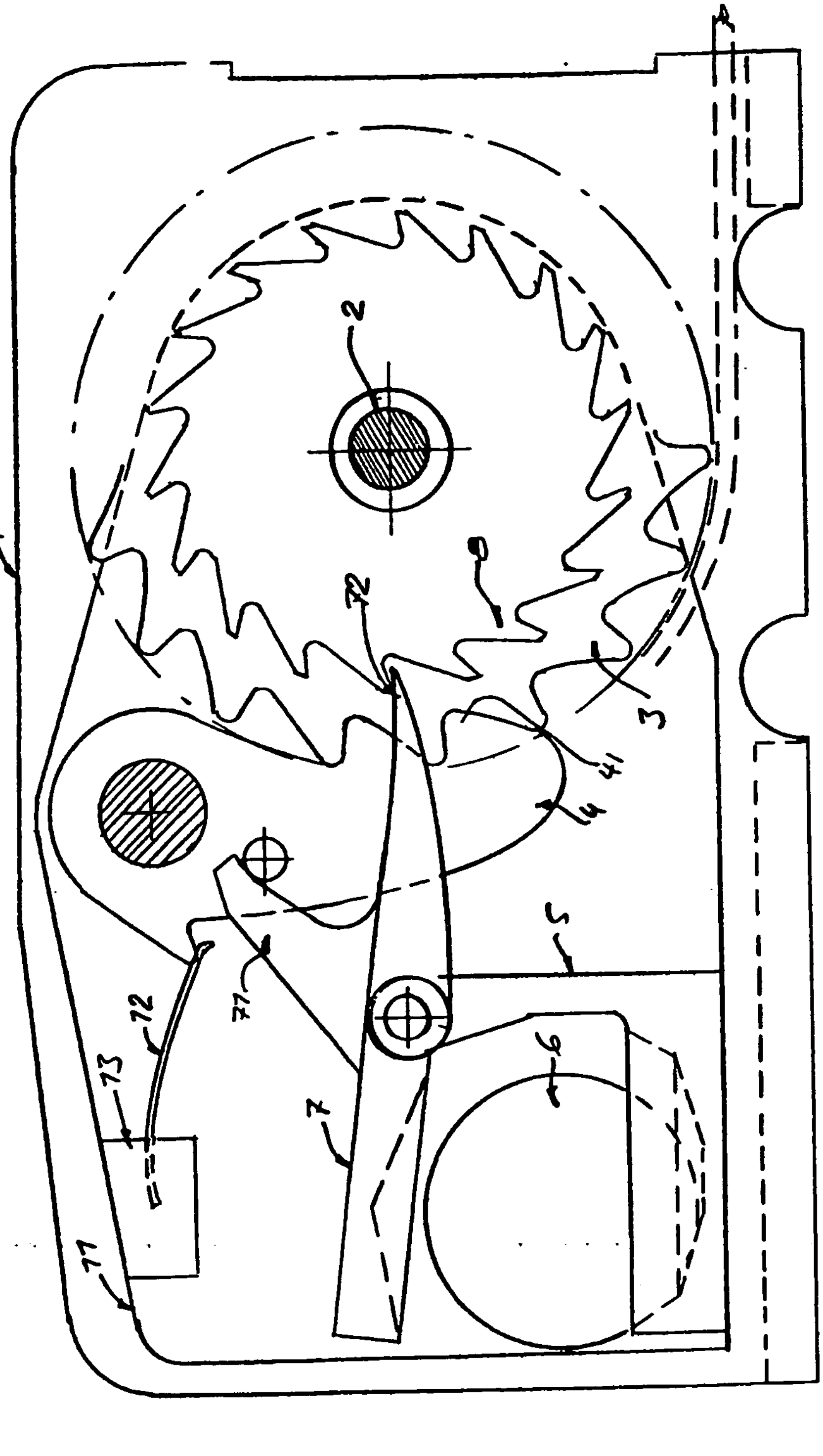


Fig 6

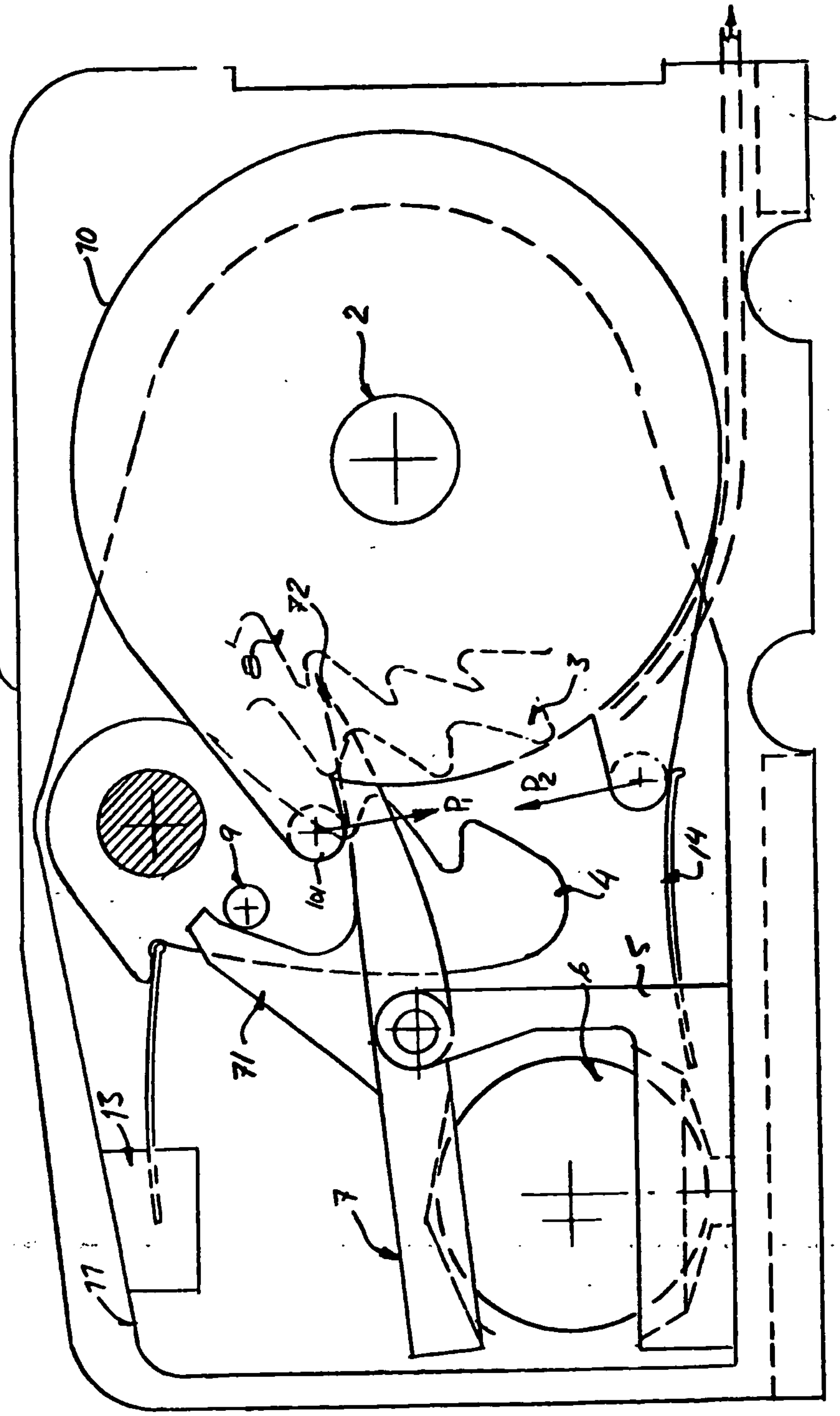


Fig 7

SPECIFICATION

**Locking device for a belt retractor in safety belts**

The invention relates to a locking device for a belt retractor for safety belts, in particular in motor vehicles, having a winding shaft and a ratchet wheel with locking teeth mounted thereon, with which, upon response of a sensor system, a movable pawl which is rotatable about a shaft secured on the housing and is tensioned in position of rest, preferably by spring action, can be brought into locking engagement, the sensor system comprising a rotatable trip lever and responding to accelerations of the belt webbing extraction and/or the vehicle in excess of a limit value.

A locking device for a belt retractor must lock in a narrow and precise acceleration range. At many motor vehicle manufactures narrow locking tolerances are demanded. Frequently the meshing teeth of the ratchet wheels and the pawl are not ideally pointed, and it may happen that the tips of the teeth and of the pawls impinge on one another, so that valuable time is lost while the winding shaft continues to rotate and the belt webbing can continue to be pulled out of the belt retractor. Only after a delay can the skipping tooth tips engage in the counter-serration and cause the locking. The uncertainty range from the state just before the engagement of the counter-serration to the final complete engagement state is thereby increased.

From U.S. Pat. 3,918,658 a locking device with ratchet wheel, sensor system and trip lever is known. Upon acceleration, deceleration or rollover of the vehicle, i.e. when exceeding a threshold value, the engaging tip of the trip lever comes in engagement with the teeth of an inertia wheel, thereby locking the retractor.

At the moment of collision, as is known, the pawl must absorb via teeth of the ratchet wheel the entire occuring force, and for this reason the pawl has in this known device been separated from the trip lever. The trip lever need then only transmit the accident signal given by the sensor system to trigger an engagement function. However, the known belt retractor has the disadvantage that it is contructed with a rather complicated mechanism with inertia wheel, gear train, lever transmissions, etc.

There has been proposed a locking device of the above mentioned kind whereby it has been possible to keep the sum of the tolerances of the individual components of the locking device low and to achieve a synchronization of the teeth coming into locking engagement with one another. Since, as is known, a plurality of interengaging parts constitutes a risk for the intact functioning of the belt retractor, one must keep the sum of the tolerances lower without using high-precision and hence expensive components. The older proposal has accomplished this in advantageous manner, and this even in so-called automatics, i.e. belt retractors where the user can in the normal case pull out belt webbing slowly and return to the housing as desired, that is, he can carry out slow movement in the buckled state, while at the moment of accident prompt locking is demanded and has been assured with more or less certaintly in such a way that after the locking the belt can hardly be pulled out of the retractor or not at all.

Similarly as in the older proposal, the object of the invention is a well matched cooperation in time of the movement of the rotating ratchet wheel and of the pawl, in other words, a synchronization, to make the locking device safer.

The task of the invention therefore is the improvement of the above explained locking device, so that it can be built more completely and will not respond overnervously, and synchronization between the meshing teeth of the ratchet wheel and pawl is further ensured.

This problem is solved according to the invention in that on the trip lever a driver finger is disposed, the pawl is arranged as a separate part next to sensor system and comprises a system for engagement with the driver finger, and in the unlocked state a distance of e.g. at least 1 mm is provided between the driver finger and the engagement system. In contrast to the older solution, the sensor system, which may comprise e.g. a shell with a ball secured therein, is not attached to the pawl or on a prolongation thereof, but is a separate part next to the pawl. While the pawl is rotatably mounted on the retractor housing, the base with the shell for the ball or respectively the base for the sensor system is fixed to the housing. In some forms of realization the sensor housing may be fairly bulky, especially when relatively large sensors, e.g. balls, are used as inertia masses. Now if this sensor housing or the base is arranged, not on the pawl but separately offset to the latter and next to the pawl, the entire housing of the locking device can be built narrower. Obviously two separate parts can be lodged in a housing requiring less space than if both parts are combined in one.

By this narrower design, in particular by the division between the pawl on the one hand and the sensor system on the other, relatively larger sensor systems can also be used. In the case of balls let it be mentioned that formerly metal balls of a diameter of 12 mm were commonly used, while by the measures of the invention the diameter can now be increased to 13, 14 or even 15 mm. The advantage of the use of larger inertia masses resides in that these cannot be influenced so readily from the outside, owing to which the locking device as

a whole then appears less jumpy. In other words, the too frequent locking sometimes observed is eliminated.

This too frequent locking, which makes the belt retractor "nervous" so to speak, could occur in the older proposal under certain conditions in part also due to the fact that the spring, having pushed the pawl into the inactive position and having held it therein, could set up natural vibrations when traveling over a bumpy road. The sensor system and in the specific case the inertia ball was then supported on the spring-loaded extension of the pawl by said spring. By the natural oscillations and vibrations unintended movements could be transmitted to the ball, so that the older sensor system showed under certain circumstances in extreme conditions nervous symptoms, i.e. locked too often.

By the attachment of the sensor system on the housing of the locking device these disadvantages are automatically eliminated.

While in the older proposal the rotatable pawl is tilted after engagement of the trip lever with a trip cogwheel mounted on the winding shaft and is thereby brought into engagement with the teeth, the trip lever according to the invention needs to expend still less force. After engagement with the teeth of the trip cogwheel it suffices that through the driver finger on the trip lever a momentum is exerted on the rotatable pawl, so that its teeth come into engagement with those of the ratchet wheel. Also in the present case the pawl is again held tensioned by a spring in the normal, unlocked state. But the force thereof is small, and the mass of the pawl is still smaller as compared with the older proposal, so that the force to be transmitted by the driver finger to the engagement system on the pawl for triggering the tilting is small.

Due to the distance between the driver finger and the engagement system in the unlocked state, preferably 1 mm, possibly also 2 mm, the driver finger comes into abutment and engagement with the engagement system only after the tip of the trip lever is already in engagement with the teeth of the trip cogwheel made of plastic. Otherwise the pawl would have to be actuated directly through the trip lever. But according to the invention, this is not the case. Instead, after engagement of the trip lever with the teeth of the trip cogwheel, the belt upon rapid extraction at the moment of impact assumes the force for rotation of the trip lever and then, after overcoming the above described distance, for rotation of the pawl into locking engagement.

In other words, the pawl is not actuated directly by the trip lever, but only (via the engagement system) after the tip of the trip lever has penetrated the circumference through the tooth tips of the trip cogwheel and has come into engagement with a tooth. Consequently the weight or the inertia of the pawl cannot hinder the engagement of the tip lever into the teeth of the trip cogwheel.

According to the invention, the engagement system is expediently a pin and the driver finger is a projection extending away from the trip lever, which is arranged next to the pin on the side away from the ratchet wheel. This design has proved especially expedient, although the engagement system may also be constructed conversely in such a way that on the driver finger a pin is provided which approaches the pawl from the side when the locking is to occur. In the case of an elongated trip lever, its axis of rotation is provided approximately in the central region thereof, and the driver finger extends in a direction next to the pin in such a way that the above mentioned distance between the driver finger and the engagement system lies on the side away from the ratchet wheel.

According to the invention it is advantageous also if the driver finger has an outwardly open recess of greater width than the diameter of the pin and is disposed, in the unlocked state, at or near the pin on the side toward the ratchet wheel. Another similar form of realization with very similar advantage is characterized in that the driver finger has an outwardly closed hole whose width is greater than the diameter of the pin and is disposed, in the unlocked state, at or near the pin on the side toward the ratchet wheel. On this side, therefore, a guide or wall applies directly against the pin, also in the unlocked inoperative state. As a result, the pawl in its movement immediately forces the trip lever to pivot and to engage, so that thereby locking is initiated and the advantageous synchronization effect according to the invention is seen especially clearly. Independently of the system which triggers the pivoting of the pawl, there is synchronization between the pawl and trip lever in any event.

In a specific embodiment, where only an inertia ball is provided as sensor system, it is quite conceivable that the pawl will rotate in the direction of the teeth of the ratchet wheel even without the ball moving, for instance because a suitable shock against the vehicle acts faster and directly on the pawl. Then the synchronization is still ensured by the principles of the invention, i.e. the teeth of the pawl enter into the correct counter-teeth of the ratchet wheel. Thereby the skipping of teeth, as observed in some known locking devices, is advantageously avoided.

By the construction acccording to the invention, the trip lever is brought into engagement with the trip cogwheel practically by the active force of the moving pawl, so that provision for synchronized locking is always made.

For further improvement of the device it is provided according to the invention that the

pawl has at least two teeth matching the teeth of the ratchet wheel. Thereby wear can be reduced considerably, without increased manufacturing costs or space requirements.

According to the invention it is further advantageous if the trip lever can be brought into engagement with the teeth of a trip cogwheel mounted on the ratchet wheel and if the ratchet wheel and trip cogwheel have the same number of teeth. The synchronization is thereby best ensured. Because of the necessarily inevitable tolerances in manufacture, one can further give the teeth of the pawl a slight lead with respect to the locked state in the direction of rotation of the ratchet wheel upon belt extraction, which means that the teeth in the ratchet wheel still have a short time for applying against the teeth of the pawl after the pawl has been turned completely into locking engagement.

In further advantageous development of the invention, the trip lever is so balanced or spring-tensioned with respect to its axis of rotation that its engagement tip is, in the unlocked state, spaced from the trip wheel. For example, a leaf spring, extension spring or compression spring or corresponding physical configuration may be provided on the trip lever in such a way that it remains in the desired unlocked position either by spring force or by weight. But the tensioning force must be so slight that the sensor system is able at all times to overcome it without impairing rapid response of the belt retractor.

It is further advantageous if the pawl has also a means for engagement with a further sensor member. For example, on the side opposite the teeth with respect to the axis of rotation of the pawl there may be conceived a feeler arm or gripping finger, against which the driver finger of an acceleration sensor, e.g. a capsule fastened on the winding shaft, can strike in order to rotate the pawl. Alternatively there may be conceived an electromagnet or a corresponding counterpiece on the pawl, with which an additional sensor member interacts. For example, at the moment of accident an electric circuit may be closed and set the pawl into rotation electromagnetically. This rotation may of course be initiated also be pneumatic or hydraulic means. In any case, the pawl, if it itself executes the rotational movement first, then forces the trip lever into synchronization.

Further advantages, features and possibilities of application of the present invention are evident from the following description of preferred embodiments in connection with the drawings, in which:

*Figure 1* shows a schematic sectional view through a locking device in the unlocked state;

*Figures 2 to 4*, various forms of realization of the front end of the trip lever shown broken off, with driver finger;

*Figure 5*, the same illustration as in Fig. 1, but showing the state of the device immediately before initially rotation of the pawl and after rotation of the trip lever;

*Figure 6*, still another state of the device of Fig. 1, namely in locking engagement; and

*Figure 7*, another form of the locking device with acceleration sensor.

Safe and synchronized locking of a belt retractor, e.g. of a so-called automatic, is obtained with a device as will be explained below with reference to the forms of realization.

In the base 1 of a locking device is mounted, according to Fig. 1, a winding shaft 2 for the belt webbing shown schematically in dash-dot lines at the bottom. On the shaft a ratchet wheel 3 is mounted, and in addition there is mounted on shaft 2 a trip cogwheel 8, preferably of plastic, and in the form of Fig. 7 additionally an acceleration sensor 10 in the form of a capsule with fingers.

In the representation of the figures, to the left of the ratchet wheel 3 a pawl with teeth 41 is pivotable about an axis of rotation 42. When the pawl passes from the state shown in Fig. 1 to the state shown in Fig. 6, the teeth 41 of pawl 4 come into engagement with the teeth of the ratchet wheel 3, and the ratchet wheel 3 together with winding shaft 2 is locked. Hence further belt extraction is impossible, and the person seated in the vehicle is protectively restrained at the moment of accident.

To the left of the axis of rotation 42 pawl 4 has a lug 43, under which the spring 12 fastened to a mount or bracket 13 engages in such a way that pawl 4 is normally tensioned into the unlocked position shown in Fig. 1. In addition pawl 4 carries a pin 9 below and to the left of the axis of rotation 42.

In the forms of realization here shown, pawl 4 is in engagement under tensile stress, but alternatively a differently constructed pawl may be conceived rotatably mounted in such a way that it fulfills the same function under compression or pressure.

In all forms of realization here shown, a sensor system with inertia ball 6 is shown, mounted on a sensor housing 5 formed as a base with shell. The dimensions of the shell are seen in broken lines, which shell permits in the case of a momentum transmitted to the sensor housing via the belt retractor a lateral shifting of the inertia ball 6. At the upper end of the sensor housing 5, a trip lever 7 is disposed pivotable over an axis of rotation 75. In the region of the ball this trip lever also has a recess, and on the opposite side it has a kind of tip, but which need not necessarily be pointed in the geometric sense. However, a faster response is favored by a more pointed design. In the central region of the trip lever 7 the driver finger 71 protrudes upward to the left of pin 9.

The trip lever 7 comes into engagement by its tip 72 with the cogs of a trip cogwheel 8 made of plastic, when by a transmitted momentum the inertia ball 6 has been pushed to the left or right due to the inertia of the mass in the shell of the sensor housing and consequently the trip lever 7 turns clockwise according to the represented figures.

The form of the trip lever 7 according to Figs. 1 and 5 to 7 is shown in Fig. 2, while in Figs. 3 and 4 other designs of the driver finger 71 are shown. But in all embodiments one sees the distance—designated by *a* in Fig. 1—between driver finger 71 and pin 9, namely on the side opposite the ratchet wheel 3 with respect to pin 9. This distance does not exist on the side toward the ratchet wheel 3, i.e. to the right of pin 9, as is illustrated in the drawing. In Fig. 3 the driver finger 71 is formed with a recess 73 open to the outside. The right side of pin 9, therefore, applies against the guide or wall located there likewise to the right of recess 73.

The same situation exists also in the form of realization of Fig. 4, where pin 9 is retained in an externally closed hole 74. The latter may also be formed as an oblong hole.

Essential for the function of locking is the fact that pawl 4 is actuated by trip lever 7, i.e. rotated in the direction of locking engagement (counter-clockwise) only after tip 72 of trip lever 7 is in engagement with the cogs of the trip cogwheel 8, and is continued to be rotated by the force of the traction on the belt and hence the torque of the plastic cogwheel 8 from attainment of the state shown in Fig. 5 clockwise until the state shown in Fig. 6 is reached. The shifting of the pawl by the trip lever 7 thus occurs only in the region between the states from Fig. 5 to Fig. 6.

By the distance between finger 71 on the one hand and pin 9 on pawl 4 on the other, which may preferably be 1 to 2 mm, it is ensured that as the inertia ball 6 moves from the state of Fig. 1 to that of Fig. 5, trip lever 7 can be rotated without load, in particular without load of the inertia mass of pawl 4, from the state of Fig. 1 into that of Fig. 5.

So, when at the moment of accident, by displacement of the inertia ball 6 into the state of Fig. 5, trip lever 7 has reached the position shown in Fig. 5 and hence finger 71 just applies against the outer surface of pin 9 on pawl 4, and when then necessarily belt webbing is extracted by forward movement of the passenger, the winding shaft 2, ratchet wheel 3 and trip cogwheel 8 rotate. Thereby, through engagement of the teeth of the plastic wheel 8 with the tip 72 of trip lever 7 the latter is rotated out of the state of Fig. 5 into that of Fig. 6. In so doing, the driver finger 71 pushes pin 9 and hence pawl 4 into the locking engagement shown in Fig. 6. This engagement is correctly synchronized, because in proportion to the distance between the axis of rotation 75 and the tip 72 of trip lever 7 the teeth on the trip cogwheel 8 are positioned to those on ratchet wheel 3 under the angle previously adjusted to the desired size.

The particular advantage of the form of finger 71 according to Fig. 3 and 4 can be illustrated especially well with reference to Fig. 7. In other words, it can be conceived that pawl 4 can be set in counter-clockwise motion also by other factors without the inertia ball 6 triggering the rotational process. For example, an acceleration sensor 10, e.g. a rotary acceleration sensor which is fastened on the winding shaft 2 and carriers a finger 101 on the left, may contribute to the movement of pawl 4 through a wedge surface on pawl 4 not shown here. Alternatively another finger not shown instead of finger 101 may conceiveably be disposed further up on the acceleration sensor 10 in such a way that the latter acts via a lever at the top of pawl 4, also not shown, to initiate the rotary movement thereof. Also other forces acting from the outside, not shown here, can initiate the rotary movement of pawl 4, e.g. electromagnets, pneumatic or hydraulic cylinders, etc.

In the form of realization of Fig. 7, finger 101 on the acceleration sensor 10 presses on the trip lever 7, so that the driver finger 71 abuts on pin 9 without the inertia ball 6 having become operative. A further depression or turning of trip lever 7 clockwise by exertion of force $P_1$ by finger 101 on the right half of the trip lever causes the latter to rotate pawl 4 into locking engagement. $P_2$ is the force of a spring 14 which strives to rotate the acceleration sensor 10 back into its normal position. In the state illustrated in Fig. 7, this force $P_2$ is readily just overcome by force $P_1$.

Conceivable also is a form of realization wherein the inertia ball 6 can, by suitable design of the shell in base 5 or by its weight or the like, transmit to the trip lever 7 such a force of so great a momentum that by its torque it can help to bring pawl 4 into locking engagement.

Although using the trip cogwheel 8 with the relatively pointed teeth for the engagement with the trip lever 7 is safer against rebound, alternatively the teeth of the ratchet wheel 3 could be used to provide the engagement with the trip lever 7.

## CLAIMS

1. Locking device for a belt retractor for safety belts, in particular in motor vehicles, having a housing including a winding shaft and a ratchet wheel with locking teeth mounted thereon, with which, upon response of a sensor system, a movable pawl which is rotatable about a shaft secured on the housing and is tensioned in position of rest, preferably by spring action, can be brought into locking engagement, the sensor system comprising a

rotatable trip lever and responding to accelerations of the belt webbing extraction and/or of the vehicle in excess of a limit value, characterized in that on the trip lever (7) a driver finger (71) is disposed, the pawl (4) is arranged as a separate part next to the sensor system (5,6; 10) and comprises a system (9) for engagement with the driver finger (71), and in the unlocked state a distance is provided between the driver finger (71) and the engagement system (9).

2. Locking device according to claim 1, characterized in that the engagement system (9) is a pin and the driver finger (71) a projection extending from the trip lever (7) and disposed next to the pin (9) on the side away from the ratchet wheel (3).

3. Locking device according to claim 1 or 2, characterized in that the driver finger (71) has a recess (73) open outwardly, of greater width than the diameter of the pin (9) and is arranged in the unlocked state at or near the pin (9) on the side toward the ratchet wheel (3).

4. Locking device according to claim 1 or 2, characterized in that the driver finger (71) has an externally closed hole (74) whose width is greater than the diameter of the pin (9) and is arranged in the unlocked state at or near the pin (9) on the side toward the ratchet wheel (3).

5. Locking device according to one of claims 1 to 4, characterized in that the pawl (4) has at least two teeth (41) matching the teeth of the ratchet wheel (3).

6. Locking device according to one of claims 1 to 5, characterized in that the trip lever (7) can be brought into engagement with the teeth of a trip cogwheel (8) secured on the ratchet wheel (3) and that the ratchet wheel (3) and trip cogwheel (8) have the same number of teeth.

7. Locking device according to one of claims 1 to 6, characterized in that the trip lever (7) is balanced or tensioned with respect to an axis of rotation (75) in such a way that in the unlocked state its engaging tip (72) is spaced from the trip cogwheel (8).

8. Locking device according to one of claims 3 to 7, characterized in that the pawl (4) has also a means for engagement with a further sensor member.

9. Locking device according to claim 1, characterized in that the sensor system (5,6; 10) comprises a ball (6) and cup (5), and the trip lever (7) is responsive to movement of the ball (6).

10. A locking device for safety belt retractor, such locking device being constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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